

P A T E N T C L A I M S

1. A fluoroalkylphosphate salt of formula (I)



(I)

wherein

10 M^{a+} is a monovalent, divalent or trivalent cation;

15 a is 1, 2 or 3;

b is 2 for $a = 1$,b is 2 for $a = 3$, andb is 1 for $a = 2$;20 and, in each case, subscripts n, m, x and y satisfy the following
relationships25 $1 \leq n \leq 8$,0 $\leq m \leq 2$ for $n = 1$ or 2,0 $\leq m \leq 4$ for $3 \leq n \leq 8$,30 $1 \leq x \leq 12$,0 $\leq y \leq 2$,

where R_1 and R_2 are each independently, fluorine, hydrogen, alkyl having 1 to 8 carbon atoms, fluoroalkyl having 1 to 8 carbon atoms or perfluoroalkyl having 1 to 8 carbon atoms; and

5 wherein the substituents ($C_nF_{2n+1-m}H_m$) are in each case identical or different.

2. A fluoroalkylphosphate salt according to Claim 1, wherein the cation M^{a+} is an alkali metal cation.

10 3. A fluoroalkylphosphate salt according to claim 2, wherein cation M^{a+} is a lithium, sodium or potassium cation.

15 4. A fluoroalkylphosphate salt according to Claim 3, wherein the cation M^{a+} is a lithium cation.

5. A fluoroalkylphosphate salt according to Claim 1, wherein the cation M^{a+} is a magnesium or aluminum cation.

20 6. A fluoroalkylphosphate salt according to Claim 1, wherein the cation M^{a+} is an organic cation

7. A fluoroalkylphosphate salt according to Claim 6, wherein the cation M^{a+} is a nitrosyl cation, a nitryl cation or an organic cation selected from the 25 formulae

$[N(R^7)_4]^+$, $[P(R^7)_4]^+$, $[P(N(R^7)_2)_4]^+$ and $[C(N(R^7)_2)_3]^+$,

wherein R^7 , in each case independently, is

30 H, C_{1-10} -alkyl or A,

5 where one or more H atoms in the C₁₋₁₀-alkyl chain may each individually be replaced by fluorine, an aromatic radical which optionally contains one or more heteroatoms, or a cycloalkyl radical which optionally contains one or more heteroatoms, and/or one or more C atoms in the alkyl chain may be each individually replaced by a heteroatom, and

10 A is an aromatic or cycloaliphatic radical, in each case optionally containing one or more heteroatoms.

15 8. A fluoroalkylphosphate salt according to claim 7, wherein A is in each case a 5- or 6-membered aromatic radical which optionally contains nitrogen, sulfur and/or oxygen atoms, or a cycloalkyl radical having 5 or 6 members.

20 9. A fluoroalkylphosphate salt according to claim 8, wherein A is phenyl or pyridyl.

25 10. A fluoroalkylphosphate salt according to Claim 6, wherein the M^{a+} is a nitrosyl cation, a nitryl cation or an organic cation selected from the formulae

[N(R⁷)₄]⁺, [P(R⁷)₄]⁺, [P(N(R⁷)₂)₄]⁺ and [C(N(R⁷)₂)₃]⁺,

wherein R⁷ are in each case, independently, are

H, C₁₋₁₀-alkyl or A,

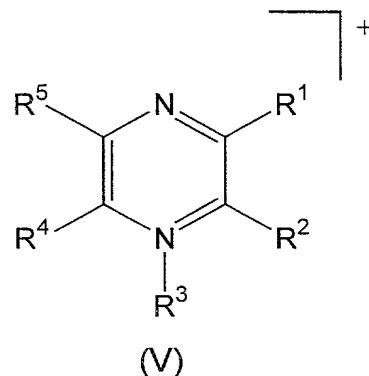
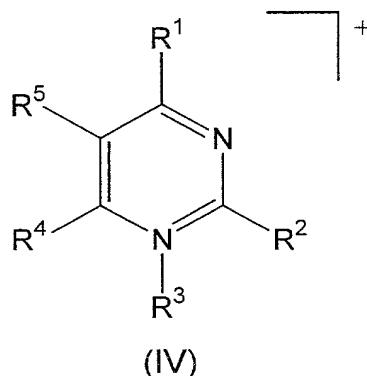
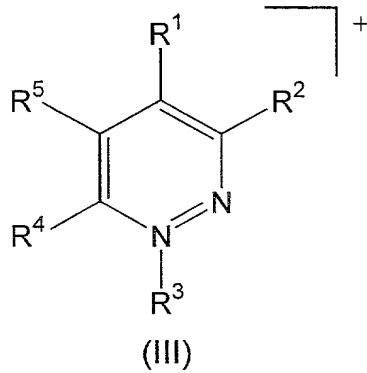
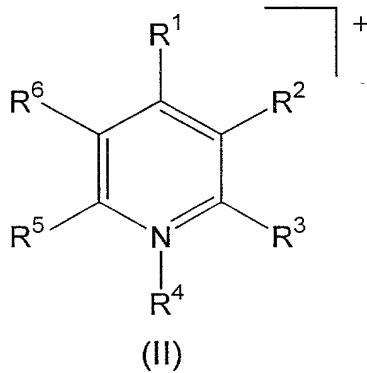
30 where one or more H atoms in the C₁₋₁₀-alkyl chain may each individually be replaced by fluorine, a 5- or 6- membered aromatic radical which optionally contains one or more heteroatoms selected from N, O and S,

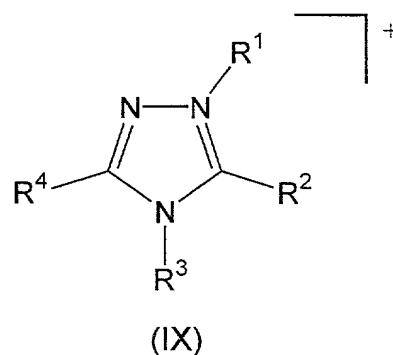
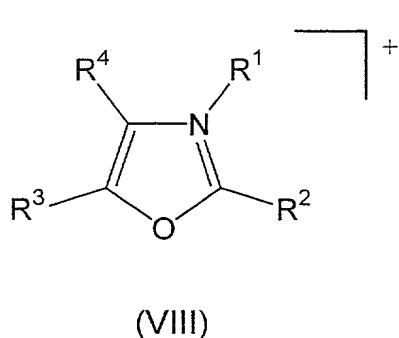
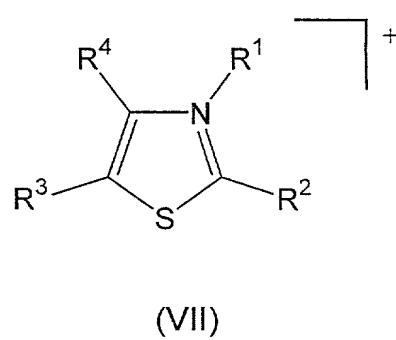
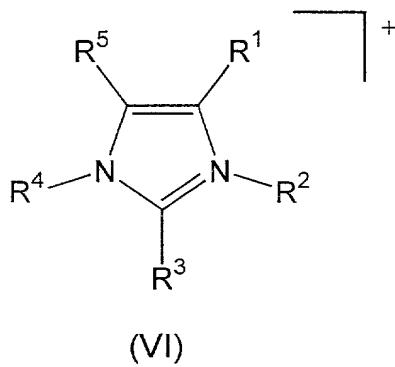
or a 5- or 6- numbered cycloalkyl radical which optionally contains one or more heteroatoms selected from N, O and S, and/or one or more C atoms in the C₁₋₁₀-alkyl chain may be each individually replaced by oxygen, and

5 A is an aromatic or cycloaliphatic radical, in each case optionally containing one or more heteroatoms.

11. A fluoroalkylphosphate salt according to Claim 1, wherein M^{a+} is a heteroaromatic cation of formulae (II) to (IX)

10





wherein

R¹ to R⁶ are each independently, H, halogen, or a C₁₋₈-alkyl radical

which is optionally substituted by F, Cl, N(C_rF_{(2r+1-s)H_s})₂, O(C_rF_{(2r+1-s)H_s})₂,

SO₂(C_rF_{(2r+1-s)H_s}) or C_rF_{(2r+1-s)H_s}, in which 1 ≤ r ≤ 6 and 0 ≤ s ≤ 13, and

2r+1-s ≥ 0, or

one or more adjacent pairs of R¹ to R⁶ can together be a C₁₋₈-alkylene

radical which is optionally substituted by F, Cl, N(C_rF_{(2r+1-s)H_s})₂,

10 O(C_rF_{(2r+1-s)H_s})₂, SO₂(C_rF_{(2r+1-s)H_s}) or C_rF_{(2r+1-s)H_s}, in which 1 ≤ r ≤ 6 and 0

≤ s ≤ 13, and 2r+1-s ≥ 0,

where each of R¹ to R⁶ cannot be halogens if they are bonded directly to nitrogen.

15 12. A fluoroalkylphosphate salts according to Claim 10, wherein R¹ to R⁶ are each independently H, fluorine, or a C₁₋₈-alkyl radical which is optionally substituted by F, Cl, N(C_rF_{(2r+1-s)H_s})₂, O(C_rF_{(2r+1-s)H_s})₂, SO₂(C_rF_{(2r+1-s)H_s}) or

$C_rF_{(2r+1-s)}H_s$, in which $1 \leq r \leq 6$, or $0 \leq s \leq 2r+1$, and $2r+1-s \geq 0$, and where each of R^1 to R^6 cannot be fluorine if they are bonded directly to nitrogen.

5 13. A fluoroalkylphosphate salt according to Claim 1, wherein $1 \leq n \leq 6$.

10 14. A fluoroalkylphosphate salt according to Claim 13, wherein $1 \leq n \leq 3$.
 $1 \leq x \leq 4$.

15 15. A fluoroalkylphosphate salt according to Claim 1, wherein $1 \leq x \leq 8$.

20 16. A fluoroalkylphosphate salt according to Claim 15, wherein $1 \leq x \leq 4$.

25 17. A fluoroalkylphosphate salt according to Claims 1, wherein $m = 0$.

30 18. A fluoroalkylphosphate salt according to Claim 1, wherein $y = 2$.

19. A fluoroalkylphosphate salt according to Claim 1, wherein R_1 and R_2 are each fluorine.

20. A fluoroalkylphosphate salt according to Claim 1, wherein said salt is
 $(Li^+)_2[(C_2F_5)_2PF_3(CF_2)_2PF_3(C_2F_5)_2]^{(2-)}$
or
 $(N(C_2H_5)_4^+)_2[(C_2F_5)_2PF_3(CF_2)_2PF_3(C_2F_5)_2]^{(2-)}$

21. A process for the preparation of a fluoroalkylphosphate salt according to Claim 1, comprising:
reacting at least one fluoro- α,ω -bis[(fluoroalkyl)fluorophosphorano]alkane with at least one fluoride salt of the formula (X)

$$(M^{a+}) [F]_a$$

(X)

5 in which (M^{a+}) and a are as defined in Claim 1, in solution to obtain a
fluoroalkylphosphate salt of the formula (I), and said salt is optionally,
purified and/or isolated.

22. A process according to Claim 21, wherein said at least one fluoro- α,ω -
10 bis[(fluoroalkyl)fluorophosphorano]alkane is a compound of formula (XI)

$$(C_nF_{2n+1-m}H_m)_yPF_{4-y}(CR_1R_2)_xPF_{4-y}(C_nF_{2n+1-m}H_m)_y$$

(XI)

15 in which

$1 \leq n \leq 8$, $0 \leq m \leq 2$ for $n = 1$ or 2 , $0 \leq m \leq 4$ for $3 \leq n \leq 8$, $1 \leq x \leq 12$,
 $0 \leq y \leq 2$,

20 R_1 and R_2 are each, independently, fluorine, hydrogen, alkyl having 1 to
8 C atoms, fluoroalkyl having 1 to 8 C atoms or perfluoroalkyl having 1
to 8 C atoms, and

25 substituents $(C_nF_{2n+1-m}H_m)$ are in each case identical or different.

23. A process according to Claim 21, wherein the compound of the formula
(X) is employed in an excess of up to 10 fold, based on the amount of
fluoro- α,ω -bis[(fluoroalkyl) fluorophosphorano]alkane(s).

30 24. A process according to one of Claim 21, wherein the reaction with the
compound of formula (X) is carried out at a temperature of -35 to $+80^\circ C$.

25. A process according to one of Claim 21, wherein that the solvent employed is ethylene carbonate, propylene carbonate, butylene carbonate, dimethyl carbonate, diethyl carbonate, ethyl methyl carbonate, methyl propyl carbonate, methyl formate, ethyl formate, methyl acetate, ethyl acetate, methyl propionate, ethyl propionate, methyl butyrate, ethyl butyrate, γ -butyrolactone, diethyl ether, dimethoxyethane, diethoxyethane, dimethylformamide or dimethylacetamide, dimethyl sulfoxide, dimethyl sulfide, diethyl sulfide propane sulfone, acetonitrile, acrylonitrile, propionitrile, acetone, or an at least partially fluorinated derivative of any of these solvents, or a mixture of at least two of these solvents and/or fluorinated derivatives of these solvents.

15 26. A mixture comprising:

- a. at least one fluoroalkylphosphate salt according to Claim 1, and
- b. at least one polymer.

20 27. A mixture according to Claim 26, comprising 5 to 90% by weight of component a) and 95 to 5% by weight of component b), based on the sum of components a) and b).

25 28. A mixture according to claim 25, wherein component b) is a homopolymer or copolymer of acrylonitrile, vinylidene difluoride, methyl methacrylate, tetrahydrofuran, ethylene oxide, siloxane, phosphazene or a mixture of at least two of these homopolymers and/or copolymers.

30 29. A mixture according to Claim 28, wherein b) is a homopolymer or copolymer of vinylidene difluoride, acrylonitrile, methyl methacrylate or tetrahydrofuran.

30. A mixture according to Claim 25, wherein said polymer is at least partially crosslinked.
- 5 31. A mixture according to Claim 25, wherein said it additionally comprises at least one solvent.
32. A mixture according to Claim 31, wherein said solvent is ethylene carbonate, propylene carbonate, butylene carbonate, dimethyl carbonate, diethyl carbonate, ethyl methyl carbonate, methyl propyl carbonate, methyl formate, ethyl formate, methyl acetate, ethyl acetate, methyl propionate, ethyl propionate, methyl butyrate, ethyl butyrate, γ -butyrolactone, diethyl ether, dimethoxyethane, diethoxyethane, dimethylformamide, dimethylacetamide, dimethyl sulfoxide, dimethyl sulfide, diethyl sulfide or propane sulfone, acetonitrile, acrylonitrile, acetone, or an at least partially fluorinated derivative of the any of these solvents, or a mixture of at least two of these solvents and/or fluorinated derivatives of these solvents.
- 20 33. In an electrolyte, primary battery, secondary battery, capacitor, super capacitor or galvanic cell, containing at least one conductive salt, the improvement wherein said salt is a salt according to claim 1, optionally in combination with further conductive salts and/or additives.
- 25 34. An electrolyte according to Claim 33.
35. An electrolyte according to Claim 34, wherein the concentration of the fluoroalkylphosphate salt is 0.01 to 3 mol/l.
- 30 36. A primary battery according to Claim 33.

37. A secondary battery according to Claim 33.
38. A capacitor according to Claim 33.
- 5 39. A supercapacitor according to Claim 33.
40. A galvanic cell according to Claim 33.